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Integrating Scientific and Local Ecological Knowledge to Identify Potential Critical Habitats: A Case Study in Placentia Bay, Newfoundland.

Intégration des connaissances écologiques locales et scientifiques pour déterminer les habitats potentiellement critiques dans la baie Placentia, à Terre-Neuve.

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Abstract

Placentia Bay is a large, biologically productive bay that supports a diverse range of marine species as well as valuable commercial and recreational fisheries. Over the next two decades there will be significant coastal and marine developments in the Bay area associated with offshore oil production and transportation. The Oceans Programs Division in Newfoundland and Labrador has identified the region as a priority for the development of an integrated management (IM) plan. Although there is a considerable amount of baseline ecological data available for a few commercial fish, sea bird and marine mammal species, little is known about many others and an integrated knowledge base for the coastal region is not available. We initiated a research program to document the local ecological knowledge (LEK) of fishers and community members regarding marine mammals (primarily harbour seals), pelagic fish (capelin and herring), and the location of environmentally significant or sensitive areas/habitats in Placentia Bay. A total of 38 participants, the majority being current and retired fishers, were interviewed by Department of Fisheries and Oceans personnel familiar with marine mammals and pelagic fishes. The questions and discussions were designed to obtain comprehensive information on the seasonal distribution, relative abundance, reproductive biology, habitat use and sensitivity of a particular species and/or habitat. Coastal areas covered by those interviewed overlapped so that information could be cross-validated. All data were compiled in a relational database and map locations provided by residents were digitized using MapInfo. Locations of capelin spawning beaches, winter and spring aggregations of herring and harbour seal pupping and haul-out sites throughout the Bay were identified. However, more importantly, there were clear spatial and temporal links between pelagic forage fish distribution, marine mammal distribution and resident's perception of environmentally sensitive areas in the Bay. These productive 'hot spots' were associated with a high diversity and biomass of marine species at certain times of the year and they warrant further study as potential critical habitats.

Résumé

La baie Placentia est une grande baie biologiquement productive qui fait vivre une grande variété d'espèces marines et soutient d'importantes pêches commerciales et sportives. Au cours des deux prochaines décennies, les activités de production et de transport du pétrole des gisements situés au large des côtes bouleverseront l'environnement côtier et marin de la région. La Division des programmes sur les océans à Terre-Neuve-et-Labrador considère la région comme prioritaire pour l'élaboration d'un plan de gestion intégrée. Alors que la documentation écologique de référence est abondante pour quelques espèces de mammifères marins, d'oiseaux de mer et de poissons d'intérêt commercial, l'information est minime concernant beaucoup d'autres espèces, et on ne dispose pas de base de connaissances intégrée. Nous avons entrepris un programme de recherche pour consigner les connaissances écologiques locales des pêcheurs et habitants de la région concernant les mammifères marins (principalement le phoque commun), les poissons pélagiques (capelan et hareng) et les zones ou habitats écologiquement importants ou sensibles dans la baie. Des membres du personnel du ministère des Pêches et des Océans ayant une bonne connaissance des mammifères marins et des poissons pélagiques ont interviewé au total 38 personnes, des pêcheurs actifs ou à la retraite pour la plupart. Les questions et les discussions ont été orientées de manière à favoriser la communication de données détaillées sur la répartition saisonnière, l'abondance relative, les aspects biologiques de la reproduction, l'utilisation des habitats et la vulnérabilité d'espèces et /ou d'habitats particuliers. Les parties de la côte couvertes par les participants se chevauchant, l'information a pu être contrevalidée. Toutes les données ont été entrées dans une base de données relationnelle, et les repères cartographiques fournis par les participants ont été numérisés à l'aide de MapInfo. Les plages de frai du capelan, les zones de concentration du hareng en hiver et au printemps ainsi que les échoueries et sites de mise bas du phoque dans la baie ont été localisés. Un constat particulièrement intéressant est la nette correspondance spatiale et temporelle de l'information sur la distribution du poisson fourrage pélagique et de celle des mammifères marins avec les perceptions des résidants concernant les zones écologiquement sensibles dans la baie. Ces lieux hautement productifs présentent une grande variété et une forte biomasse d'espèces marines à certaines périodes de l'année et méritent d'être étudiés en tant qu'habitats potentiellement critiques.

Introduction

Placentia Bay is a large, biologically productive, ice-free bay that provides habitat for a diverse range of marine species, supports valuable commercial, recreational and subsistence fisheries, and is home for numerous coastal communities (Brander-Smith 1990). The Oceans Programs Division, Department of Fisheries and Oceans has identified Placentia Bay as one of the priority areas in Newfoundland and Labrador Region to develop an integrated management (IM) plan. As a first step towards implementing the plan, an ecosystem overview (from both the biophysical and socio-economic perspective) is currently being compiled. Although this work is still preliminary, it is apparent that considerable scientific knowledge is available for key commercial groundfish species, sea birds in the vicinity of Cape St. Mary's and some migratory marine mammal species, but for many other species very little is known. Perhaps more importantly, there are large knowledge gaps concerning many aspects of ecosystem processes and functions in the area (e.g. multi-species interactions, food web dynamics, and contaminant pathways). In addition, there is little research effort focused on developing ecosystem indicators as tools for the future IM plan and marine ecosystem quality (MEQ) assessments for the Bay.

Offshore oil production and related industry activity in Placentia Bay includes the NARL Oil Refinery at Come By Chance, the Marystown Shipyard, the Cow Head Offshore Oil Fabrication Facility, and the Offshore Oil Transshipment Facility located at Whiffen Head. The Bay is an area of expanding marine transportation and coastal development; within five years it will likely be the largest oil handling port in Canada (Environ. Assess. Panel, 1997). Concurrent with this expansion of the offshore oil industry, the Bay has been identified as the marine area with the highest potential for an oil related environmental accident in Canada (Brander-Smith 1990). Other historical sources of industrial contaminants in the Bay include a decommissioned US naval base, an elemental phosphorous plant and a fluorspar mine. In the near future, a new nickel smelter and refinery complex will be located at the site of the former naval base (Voisey's Bay Nickel Company, a subsidiary of INCO).

Coastal development, stemming directly and indirectly from offshore oil production and transportation over the next two decades, will be significant in Placentia Bay (particularly along the eastern coast). Presently the methodology for monitoring these types of long-term cumulative effects on the conservation of ecologically important areas and on the sustainable utilization of fishery resources in coastal areas is not adequate. To address these types of data gaps three research projects were initiated and linked as follows: 1) evaluation of the harbour seal (*Phoca vitulina*) as an indicator species for upper trophic level health in Placentia Bay and surrounding coastal waters (Boulva and McLaren 1979; De Swart *et al.* 1996; Bernt *et al.* 1999; Lebeuf *et al.* 1999; Ross 2000; Harwood 2001), 2) identification of location and timing of capelin (*Mallotus villosus*) and herring (*Clupea harengus harengus*) spawning in Placentia Bay (Carscadden *et al.* 1997; DFO 2000; Nakashima and Wheeler 2002), and 3) implementation of the Placentia Bay environmentally significant areas project (Newfoundland and Labrador Oceans Programs Division). Both the capelin/herring project and the significant areas project were based entirely on the collection of local ecological knowledge (LEK) through interviews with coastal residents (e.g. Neis *et al.* 1999 a,b). The focus of the harbour seal study was primarily contaminant and marine health based, but with a significant LEK component as well. Therefore, rather than

sending three interview teams out, research efforts were combined to facilitate a more integrated and comprehensive interview process. The general objectives of the LEK component of the three projects were to:

- identify species-specific habitat as well as any areas of high marine productivity that may be environmentally significant in Placentia Bay;
- integrate DFO science-based knowledge of specific sites with local knowledge on both a seasonal and spatial scale;
- obtain a 'first look' at data deficient areas so that research interests can be identified;
- include resource users, interested residents and community members in the research process.

Although these objectives are more general than defining critical habitat from a species at risk perspective, it is hoped that this Placentia Bay case study will illustrate how local ecological knowledge (LEK) could be integrated into endangered species research and recovery planning.

Methods

The terms traditional ecological knowledge (TEK), traditional knowledge (TK), and local ecological knowledge (LEK), have all passed into common usage in the literature (e.g. Neis *et al.* 1999 a,b; Usher 2000). Usher (2000) defines TEK as knowledge of the environment derived from the experience and traditions of a particular group of people. Although Usher (2000) notes that it is appropriate to use 'traditional' in the context of aboriginal knowledge, he is of the opinion that the use of the term TEK should not be restricted by the genetics or heritage of a group of people. However, Neis *et al.* (1999 a,b) illustrates why a growing number of researchers prefer to use TEK to indicate 'aboriginal ecological knowledge' and LEK to indicate the knowledge of 'local harvesters or local resource users'. Within this framework of definitions, the use of either TEK or LEK would be appropriate for this manuscript, but given the nature of the project, the term local ecological knowledge (LEK) will be used throughout the text.

One of the most useful, and in some cases, the only source of information and knowledge on certain biological resources in Placentia Bay (Figure 1) is from the residents. We identified interview candidates with varied backgrounds and knowledge of coastal waters, including active inshore fishers, retired fishers, longtime local residents, federal fisheries and provincial conservation officers, and naturalists. Names were also compiled from contact lists of three recently completed Community Coastal Resource Inventories and from updated lists of licensed fishers in the area that were known to DFO pelagic fish and marine mammal scientists because of their past cooperation in other research programs. In addition, local fisheries officers identified potential candidates in the areas where interview coverage was lacking, as did other interview respondents.

A three-part questionnaire was designed to: 1) identify and document details related to the location and timing of capelin and herring spawning, 2) document the seasonal distribution and relative abundance of marine mammals (particularly harbour seals), and 3) identify environmentally significant or sensitive areas/habitats. The capelin related questions addressed the timing and duration of the spawning period as

well as the frequency of spawning at each site. General information on the presence of other species during the spawning period and on any physical changes to the spawning habitat was also collected. To determine the local importance of each capelin spawning site, respondents were asked to provided a relative assessment (major, average, or minor) of the contribution each site made based on use (spawning every year, occasionally, or rarely). Also included are the locations of capelin and herring aggregations, defined as areas where capelin or herring "school" or aggregate without spawning being observed, or as areas where these species are frequently targeted by fixed or mobile gear fisheries. The marine mammal questions focused on the location and seasonal use of haul-out sites, feeding areas, fisheries interactions, and pupping areas for seals and feeding areas for whales. Details on any changes in seasonal migration patterns, habitat use and relative abundance were also noted. This manuscript identifies coastal habitat commonly used by harbour seals and humpback whales (*Megaptera novaeangliae).* Environmentally significant and/or sensitive areas were defined as coastal or off-shore areas with high biodiversity and/or biomass or areas that were important habitat for breeding, foraging, rearing of juveniles or seasonal migration corridors for a particular species. Residents were asked to consider this definition and then, based on their observations and experience, identify areas of concern. Whenever possible, respondents were encouraged to address each question from both a current and longer-term perspective, particularly those related to changes in habitat use (all species), migration routes (all species), spawning areas (capelin and herring), feeding areas (all species) and haul-out sites (seals). The time periods of general interest were pre -1990, the mid 1990s and the present. For most participants the early 1990s represented a critical benchmark from an economic perspective (i.e. pending fishing restrictions and moratoriums on numerous fish stocks) as well as from an environmental perspective (i.e. the onset of a significant change in oceanographic conditions in the Northwest Atlantic).

Interview candidates were contacted a day or two ahead of time to schedule a convenient appointment. Interviews took place in the home of the respondent, or in the case of fisheries officers, at the local detachment office. They were conducted by two people, one to ask questions and mark locations and details on the map, and the other to take notes. Respondents were encouraged to locate and mark all their observations on topographical maps (1:50,000 scale) that were relevant to their area of geographic expertise (coloured pencils were used for clarity). Each person interviewed was given an individual set of maps and typically, several maps were required to cover the respondent's geographical area adequately. In some cases hydrographic charts (1:80,000 scale) were used when a respondent was more comfortable working with one or if the site in question was not easily identified on a topographic map. A coding system was used to ensure that ancillary descriptive information could be directly linked to a specific mapped location.

Because of the large numbers of maps generated from the interview process, mylar overlay sheets were used to transfer and incorporate all marked locations from maps of a particular area on to one overlay. Any information recorded on nautical charts was converted and transferred to the 1:50,000 scale mylar overlays. This process allowed all, e.g. capelin and herring, data from several topographic maps to be compiled on to one map. These mylar maps were then digitized and incorporated into a MapInfo database. All ancillary records germane to each spawning site on the digitized maps were archived in an Excel spreadsheet. These spreadsheets were then incorporated into the MapInfo database to accompany the maps.

All respondents were assigned an identification number that was used on the interview sheets, maps and databases to ensure confidentiality. At least one and preferably two or more interviews in the same area confirmed the reliability of data collected by this process. In addition, a reliability factor was assigned to each respondent in order to outline and facilitate what follow up measures may be required to verify or expand upon the information provided in the future. Relevant contact information, such as mailing address, occupation, and experience was collected from each respondent and compiled into a contact database for future reference.

Results and Discussion

All three projects discussed here are ongoing; the various MapInfo data sets are currently being validated with interview notes and all coding is being checked and standardized. Thus, the overview information presented in this working paper is preliminary and meant to demonstrate the nature and type of data that can be collected from knowledgeable resource users and residents. It is hoped that this Placentia Bay case study provides an example of how LEK may be a useful research tool in identifying potentially critical habitat from an endangered species perspective.

Figure 2 presents an overview of Placentia Bay documenting harbour seal distribution and haul-out sites, inshore humpback and minke whale sightings, capelin spawning beaches, demersal spawning beds and aggregation areas and herring spawning and aggregation areas. There are some relatively distinct areas of interest (hotspots) in terms of the occurrence and relative abundance of pelagic fish and marine mammals: 1) Lamaline/St. Lawrence, 2) Marystown 3) Swift Current and northern Merasheen Island, 4) Placentia and, 5) Cape St. Mary's. Marystown and Swift Current are estuarine habitats and do not have as high occurrence of capelin beaches and herring aggregations as the other four areas, but they do exhibit a high diversity of other species that will not be dealt with here.

To illustrate the level of detail and type of information collected as well as highlight the strengths and weaknesses of using LEK as a research tool in this type of a project, the Lamaline/St. Lawrence area will be discussed in more detail (n=7 interviews; Figure 3). A total of 31 capelin beaches were identified, eight of which were considered major sites with at least some spawning every year. There were also three capelin aggregation locations and one demersal spawning bed identified. Respondents provided good quantitative data on dates and duration of spawning as well as descriptive information on any physical habitat changes that may have occurred at any of the beaches. For some beaches respondents were able to chronicle changes in relative abundance, body size and condition, and age class structure since the early 1990s. With follow-up discussion it would be possible to collect this type of information for most of the major beaches. One of the highlights that would also be interesting to examine in more detail relates to observations of increasing abundance of capelin at certain beaches during the last two years.

In the case of herring, three spawning and three aggregation sites were identified but respondents provided less ecological information compared to capelin. For the most part, the more pelagic behaviour and life history characteristics of herring explain much

of this difference. However, there were indications that because the herring stock in the area had been over fished, fewer fishers were targeting herring and therefore not able to comment on current spawning times and locations. There is a wealth of historical herring fisheries information that could be collected in follow-up interviews.

Providing information on seals, and to a lesser degree whales, appeared to be somewhat more difficult for respondents, not because these species were not observed, but because species identification was a problem. Residents of the south coast are not seal hunters and there has never been a need for them to be able to identify seal species. However, with the use of pictures, most of those who were unfamiliar with names, were able to identify the species in their areas. There was one known harbour seal haul-out site in the area, but respondents were able to identify other areas with relatively high densities of seals sighted on a seasonal basis as well as confirm where most of the pupping takes place (comments were more variable on timing of births). Although no rivers in the Lamaline/St. Lawrence area were thought to have serious seal/salmon predation problems, Pipers Hole (Swift Current Area) and Tides Brooke (Marystown area) warrant further investigation. The distribution and timing of migration of humpback and minke whales in the area was consistently linked with the timing of capelin spawning and aggregations.

When respondents from the Lamaline/St. Lawrence area were asked to identify sites that were environmentally significant or sensitive all replied from a commercial fisheries perspective. Productive cod fishing grounds, capelin spawning areas and productive seabird habitat were the primary concerns. However, other specific areas commonly mentioned included: Cape St. Mary's; Pipers Hole (Swift Current area); Winterland marsh (Marystown area); and, a wetlands near Lamaline (St. Lawrence area; Figure 2). There was broad-based support and interest in protecting areas such as these in the future. All fishers discussed and emphasized the 'keystone' nature of capelin in the area. The potential for a large-scale oil tanker accident was cited as the most 'serious' environmental threat facing Placentia Bay.

There were no major inconsistencies in the information reported by the 7 fishers from the Lamaline/St. Lawrence area. Had there been a discrepancy, the nature and source of the problem would have been traced back to the original interview notes and evaluated from several perspectives. The most important criteria being: 1) whether the area in question was within the individual's normal fishing area, 2) whether it was a comment pertaining to a species that he/she was less familiar with (i.e. did not fish regularly), and 3) the age, time spent fishing and general depth and scope of knowledge exhibited by the fisher. In most cases, an evaluation of the problem using these criteria will clarify whether certain information should be given less weight or discarded. If this approach does not rectify the problem, then the fisher in question can be contacted for further clarification. The success of a project with a strong local knowledge component lies in the selection of experienced, knowledgeable participants with good communication skills and the ability of the interviewing team to interact with participants.

Overall the research team was able to collect a considerable amount of new information from a relatively large area where DFO pelagics and marine mammal scientists have very few projects. All the information is valuable in terms of validating the ongoing Coastal Zone Inventory project as well as providing baseline data for the Placentia Bay IM Plan and the Environmentally Significant Areas Program. It will also be important for evaluating potential cumulative effects related to the oil and gas industry in

the future. The integrated research approach achieved by combining our efforts in the field significantly improved the quality of data collected as well as enhanced the exchange of information with the participants. This case study has also demonstrated the applicability of using a LEK research approach to identify critical habitat for those endangered species we know little about.

Comments on the use of LEK in Stock Assessment Research Programs:

In recent years, it has become increasingly common practice to incorporate local or traditional knowledge in scientific studies (e.g. Ferguson and Messier 1997; Neis *et al.* 1999 a,b; Huntington 2000). In addition, it is now a National policy requirement that traditional ecological knowledge be incorporated into environmental assessments, resource management plans and conservation initiatives such as the Species at Risk Accord (Berkes *et. al.*;Usher 2000).

Incorporating local ecological knowledge and resource user participation in pelagic fish and marine mammal research and population assessment has a relatively long history in Newfoundland and Labrador Region. Capelin research scientists first initiated a research logbook program for fixed gear and purse seines in 1981 (e.g. Nakashima 1984). Fishers provided information on catch rates, relative abundance, estimates of discarding and by-catch, and fishery operations and general practices. Many involved in this program also collected biological samples. Since 1990, fishermen in selected areas around the province were requested to keep daily spawning diaries. In 1994, annual telephone interviews were initiated to obtain information and comments from resource users on relative abundance, spawning activity, and general fishing operations and activities (Nakashima 1995). Similar programs and types of data have been collected for herring; however, the time series for some programs has not been as long as it has been for capelin. There has been an index research gillnet program since 1982 that focuses on catch rates and since 1996 a fixed gear logbook program and an annual telephone survey of purse seiners (e.g. Wheeler *et al.* 2001).

In the case of marine mammal research, fisher/hunter participation in the collection of biological samples and observational data has been ongoing since 1985. The samples provided by the hunters for determining age, reproductive status, diet and general body condition are fundamental to the Marine Mammal Section's population assessment research. The observational data significantly improves our ability to interpret information on feeding behavior, changes in habitat use, changes in distribution and migration as well as relative abundance (e.g. Stenson and Sjare 1997). There has also been an ongoing marine mammal by-catch logbook program since 1990 that focuses on quantifying the number of seals, and more recently harbour porpoise, taken as by-catch in various gillnet fisheries (e.g. Walsh *et al.* 2000).

In summary, the key benefits of incorporating a LEK component into marine mammal and pelagic fish stock assessment research on a long-term basis have been to: 1) identify areas/issues of common interest for research projects and involve resource users, 2) collect biological samples, environmental information and observational data on key life history traits from a current and historic perspective, and 3) build cooperation between DFO scientists and clients based on a one on one relationship. These benefits would be particularly useful in the initial development of recovery plans for understudied endangered or threatened species.

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Appendix 1. Interview questions for the marine mammal component of the project.

1) What species of seals are seen in your area - what months are they most common? (indicate if they are rare, common, very common and map the general area of sightings)

2) What species of whales are seen in your area – what months are they most common? (indicate if they are rare, common, very common and map the general area of sightings)

3) Do you get the impression that a particular species has a specific migration route in and out of the Bay? If yes, has this route changed over time?

4) Do you have any observations on seal or whale feeding behaviour in a particular area. If so, locate the area(s) on the map and suggest why they may be important.

5) Locate the areas on the map where you see harbour seals in the water on a seasonal basis. (indicate if they are rare, common, very common)

6) Locate any favorite haul-out spots used by the seals and comment if the spot is relatively new or has been used for a long period of time.

7) Which sites do females with pups use?

8) Do you know <u>where</u> and <u>when</u> harbour seal pups are born (i.e. have you seen any very young pups)?

9) Do harbour seals or any other seals cause problems for your fishing operations. Are any other species a problem (e.g. gulls)? If so, provide details on the nature of the problem.

10) Are there any scheduled or unscheduled salmon/trout rivers in your area? Do you know any details about the run in terms of the peak smolt and adult runs?

11) Do harbour seals or any other seals, frequent any of these rivers? If so, which rivers and when.

12) Have your general observations of harbour seals changed in the last 5 years? In the last 10? If yes, do you have comments on why these changes may have occurred? (note: if the interviewee does not know something specific about harbour seals, he/she may have some comments about harp or hooded seals or whales)

Appendix 2. Interview questions for the pelagic fish component of the project.

Capelin

1) How many years has the respondent been making observations?
   How often are observations made in the summer?

2) Locate known spawning beaches and off-beach spawning sites on chart.
   (note local name if possible)

3) How often is each site occupied by capelin?
   (every year / most years / some years / rarely)

4) When does spawning take place at each site?

5) How long does spawning last?
   (one day / a few days / 1 week / several weeks)

6) Rate the importance of each identified spawning site in the area.
   (major / average / minor spawning)

7) Are there any other animals around when capelin are at these spawning sites?
   (i.e. seals, whales, seabirds, cod, etc.)

8) Have there been any permanent changes to the spawning site and when did they occur? (e.g. new wharf, new houses, new road, pollution, enhanced/increased fishing activity, storms or changes in beach sediments)

Herring

1) Locate and mark known herring spawning beds on the map provided.
   (note local name if applicable.)

2) How often does spawning at each site occur?
   (every year / most years / some years / rarely / once)

3) When does spawning take place at each site?

4) For how long does spawning take place?
   (one day /a few days / 1 week / several weeks)

5) How important is the spawning site in your opinion? (major site / average / minor)

6) Any obvious changes to the spawning area and when did they take place?
   (e.g. reduced in size, pollution, fishing pressure, etc.)

Appendix 3. Interview questions and background information to identify environmentally significant or sensitive areas.

When identifying a significant or sensitive area based on environmental factors, consider shoreline features, nearshore and offshore oceanographic features, various fish species, marine plants and mammals (including whales and seals), and seabirds. Significant or Sensitive areas may include (but are not limited to) spawning areas (capelin, herring, cod, etc), feeding grounds, juvenile rearing sites, areas of high productivity or biodiversity, seal sightings or haul-out sites, etc.

1) Are there any areas that you consider to be significant or sensitive from this perspective?

Yes_____ No_____

If yes, note why?

Spawning area
Feeding grounds
Juvenile rearing site
Other (explain)

Area of high productivity
Area of high biodiversity
Migration route
Coastal erosion (shoreline modification)

2) Is this area linked to a particular fish species, marine plant, marine mammal or seabird? If so, please identify and comment.

The physical identification of a significant/sensitive area on a map is of crucial importance. In the event of an oil spill, cleanup strategies could be designed in advance, based on the possible wind directions and weather conditions at the time of the spill, when the area is easily identifiable.

3) Identify the location of the significant/sensitive area, with accompanying boundaries, on the map(s) provided. (locate area on map using landmarks and local place names as required)

4) Has there been any recent changes, developments, disturbances made to the site/area? If so, please provide details.

Protection of the marine environment is a multi-agency responsibility, including all levels of government and non-government organizations (e.g. Come-by-Chance Wetland Stewardship Area, etc). For the area(s) you have identified:

5) What, if any, is the existing level of protection?

6) Do you think that the area(s) warrant any special protection over and above what is already provided? If so, please elaborate.

Figure 1. Map of Newfoundland with an overview of Placentia Bay.

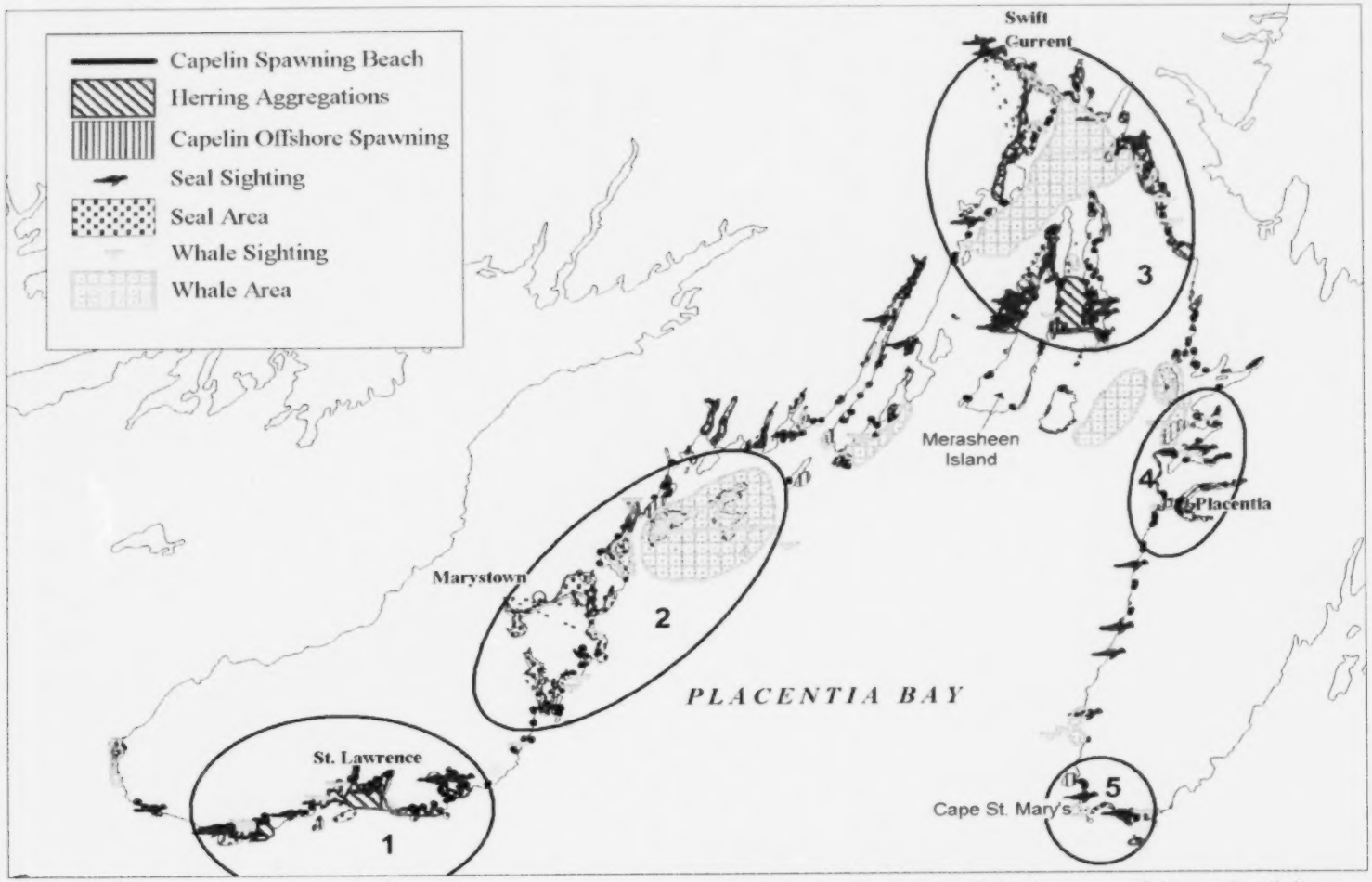

Figure 2. Areas of high pelagic fish and marine mammal (humpback whales and harbour seals) productivity and/or occurrence in Placentia Bay. Area 1 – St. Lawrence; Area 2 – Marystown; Area 3 – Swift Current / Merasheen Island; Area 4 – Placentia; Area 5 – Cape St. Mary's.

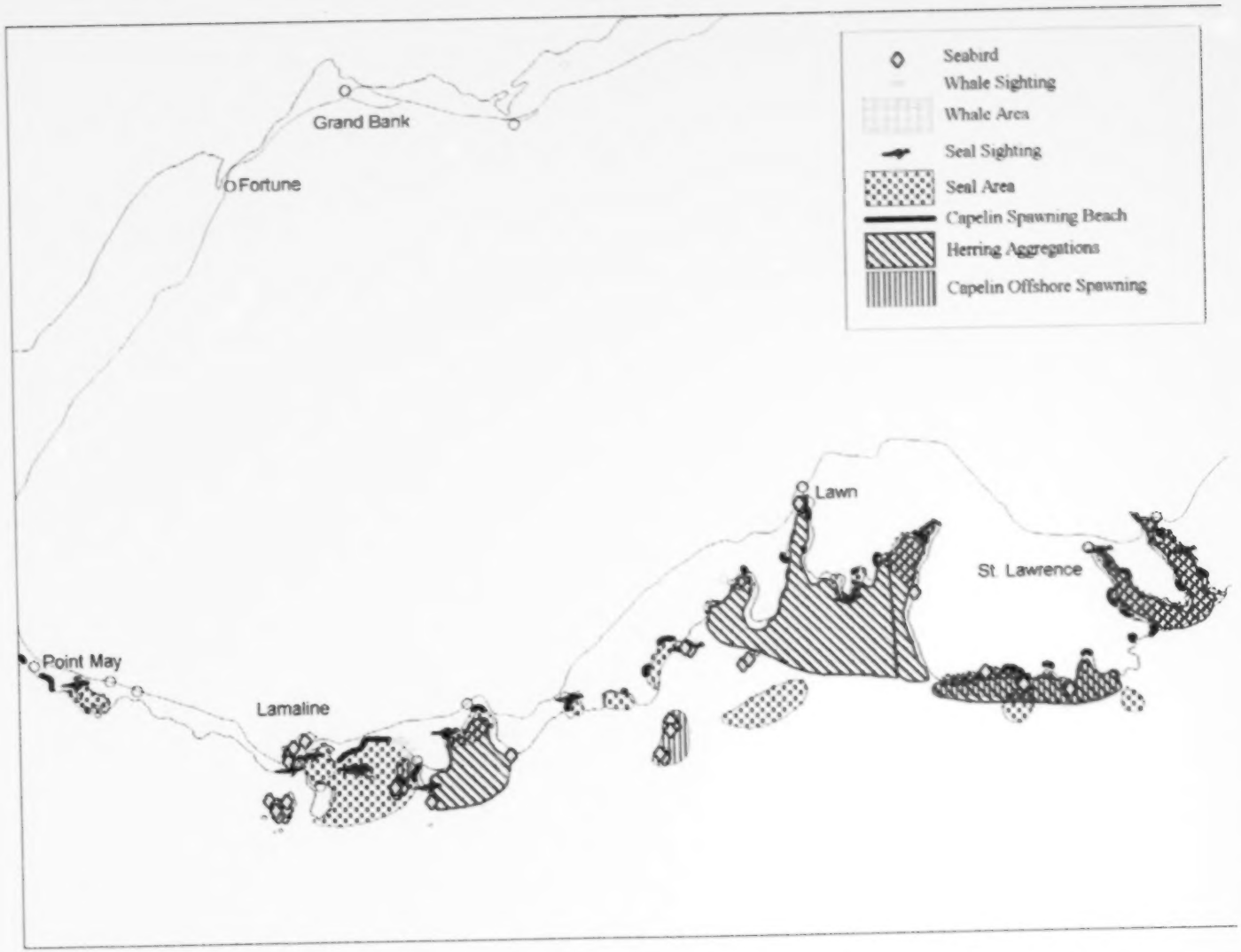

Figure 3. Distribution of marine mammals (humpback whales and harbour seals), pelagic fish and seabird aggregations (green triangles) in the Lamaline - St. Lawrence area of Placentia Bay, Newfoundland.